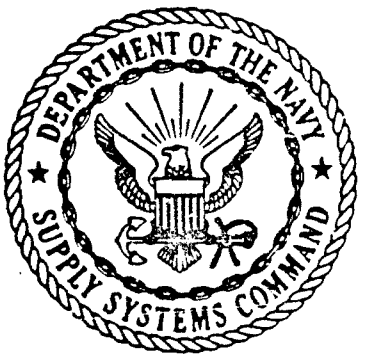
(1)

SURVEY OF HAZARDOUS CHEMICAL PROTECTIVE SUIT MATERIALS



NAVY CLOTHING AND TEXTILE RESEARCH FACILITY
NATICK, MASSACHUSETTS

TECHNICAL REPORT NO 186

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	29 April 91	Interim Report

4. TITLE AND SUBTITLE
Survey of Hazardous Chemical Protective Suit Materials

5. FUNDING NUMBERS

6. AUTHOR(S)
Andra Kirsteins
Cleveland A. Heath

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Navy Clothing and Textile Research Facility
P.O. Box 59
Natick, MA 01760-0001

8. PERFORMING ORGANIZATION REPORT NUMBER
NCTRF Report No. 186

9. SPONSORING MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Supply Systems Command
Code 04
Department of the Navy
Washington, DC 20376-5000

10. SPONSORING MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release: Distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The Navy Clothing and Textile Research Facility (NCTRF) acquired a shipboard hazardous materials list from the Naval Safety Center and conducted a survey of commercially available suit materials that could potentially provide protection against the listed materials. The types of personal protective equipment (PPE) currently used by the Navy were also investigated. Based on the survey, NCTRF has determined that a commercially available suit material may provide the desired level of protection. The most promising suit materials identified through this investigation will be laboratory evaluated for potential use in the manufacture of Navy hazardous protective clothing.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Personal Protective Equipment (PPE), Chemical Permeation Breakthrough, Hazardous Materials Response Kit	
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

TABLE OF CONTENTS

INTRODUCTION

Due to the increasing role of federal, state and local governments to control the emission, disposal, use and exposure of hazardous substances, the Navy has established a hazardous material control and hazardous waste minimization program to comply with these regulations. The Navy's goal is to minimize risks to personal safety and to the environment.

To keep in compliance with federal, state and local regulations regarding the storage, handling and usage of hazardous materials, the Navy is involved in identifying and managing the types and quantities of hazardous materials stored aboard ship, as well as the hazardous waste produced. There are hundreds of substances shipboard that are regularly used and have been designated hazardous by the Naval Safety Center. Currently, no personal protective clothing exists within the Navy supply system that is specifically designed to protect naval personnel against these substances, either during normal use and handling, or in the event of an accidental spill. For these reasons, the Navy Clothing and Textile Research Facility (NCTRF) is currently involved in developing a multipurpose fire-retardant chemical protective suit material that will be capable of protecting naval personnel against these hazardous substances. This report covers findings related to the number of materials stored aboard ship and the current availability of hazardous material protective clothing.

DISCUSSION

Hazardous Materials

Hundreds of hazardous materials are stored aboard ship that are required for routine maintenance operations. The ship's hazardous materials list (SHML), generated by the Naval Safety Center, lists these potentially dangerous substances. All materials on this list are controlled and managed by the Naval Supply Systems Command under the Hazardous Materials Afloat Program. This list does not include weapons, explosives, propellants, pyrotechnics, chemical, biological or nuclear warfare materials, medical and pharmaceutical materials, medical and infectious waste, sewage, garbage and bulk fluids.

The SHML contains many products which have been designated hazardous by the manufacturer, but those hazardous component(s) remain unidentified. David Taylor Research Laboratory is involved in minimizing the types of shipboard hazardous materials, and is currently attempting to identify the hazardous components within these products. This will enable the Navy to substitute existing products for comparable products which pose a lesser hazard.

Hazardous Materials Response Kit

The Naval Ship Systems Engineering Station (NAVSES) has just developed a Hazardous Materials Response Kit specifically designed to clean up shipboard hazardous chemicals. The newly developed kit is currently being implemented on all ships. The kit includes personal protective equipment (PPE), air monitors, and clean-up

materials and equipment. The types of PPE include Saranex/Tyvek coveralls and apron, nitrile and butyl gloves, respirator, and eye and hearing protection. The kit is designed to handle a 15 gallon spill (max.), over a one hour exposure time. The Saranex-coated Tyvek material was selected by NAVSES on the basis of a recommendation from the Naval Environmental Health Center. The manufacturer's permeation data were the primary basis for selection.

The suit is said to provide protection against 81 hazardous substances that are of concern to the Naval Environmental Health Center (no testing of the material has been performed as yet). The material was also favored because it is disposable, thus not requiring decontamination, and is inexpensive. At this time, specifications are being developed for this suit. The suit will be required to show no chemical breakthrough for one hour, using ASTM F739-85, "Resistance of Protective Clothing Materials to Permeation by Liquids or Gases" against the following chemicals: 50/50 PCB/mineral oil mixture, 98% sulfuric acid, mineral spirits, 40% sodium hydroxide and isopropyl alcohol.

Protective Clothing Survey

Chemical protective clothing is necessary to minimize the potential exposure to harmful chemicals. Typical chemical protective clothing may consist of any of the following: coat, jacket, coveralls, apron, trousers/bibs, gloves, shoe covers, boots, face shield, full body encapsulating suit and respirator.

Although the Navy currently has no protective clothing items specifically designated for protection against major shipboard hazardous chemical spills, there are efforts underway to take existing Navy protective clothing items that are available through the supply system, and designate them as "protective" for specific types of chemicals. The Office of the Chief of Naval Operations (OP45) is involved in developing a simplified guide for naval personnel, which will aid in the selection of personal protective equipment for protection against 16 classes of hazardous substances that are stored aboard ship. A draft of this manual was made available to NCTRF. The types of PPE include respiratory devices, handwear, eye, face and neck protection, along with their Navy stock numbers. All suggestions are presently based on material safety data sheets. The various types of suit materials being recommended include butyl, nitrile, neoprene and polyethylene film. The manual also gives general precautionary measures that must be taken, potential health risks, spill control measures, and a disposal guide.

The effectiveness of chemical protective clothing is dependent on the type of material, typically an elastomer or plastic film, and the quality of the garment's construction. Many types of hazardous chemical protective suit materials are available commercially. Much effort has been placed in the development of multi-purpose hazardous chemical protective materials that can provide chemical permeation protection for extended periods of

time, against a wide variety of chemicals. Not only is the type of material important, but seam construction, types of closures, and durability to pinholes, abrasion and tear resistance are of equal importance. Decontaminability must also be considered.

Levels of Protection Required

Choosing the necessary protective equipment, especially in emergency situations, may be very difficult. The Environmental Protection Agency (EPA) has categorized the necessary degree of protection required into four levels (A, B, C and D) to aid in selection.

Level A mandates the highest degree of protection where maximum skin, eye and respiratory protection is needed. Under these conditions, a totally encapsulating, vapor tight suit is required. Such a situation could exist if a high concentration of chemical is present in a confined space. Level B requires the use of a splash protective suit. For a Level B situation, the highest degree of vapor protection is required, but protection against potential harm to the skin from liquids is reduced. Level C differs from Level B, in that a lesser degree of respiratory protection is required. As in Level B, a splash protective suit is required. In a Level D situation, no respiratory hazard exists, with only minor to no skin hazard. As a result, regular work clothing provides sufficient protection.

The EPA classification describes the type of clothing required for a particular activator, but does not give a required level of

performance. The National Fire Protection Association (NFPA) is developing minimal acceptance standards for chemical protective clothing for three levels of spill emergencies:

(1) NFPA 1991 - Protection Against Chemical Vapors and Liquid Splashing in Emergency Conditions: where protection is required for response personnel against exposure to chemicals in both the liquid splash and vapor forms, when personnel are inside of the danger zone.

(2) NFPA 1992 - Protection Against Chemical Liquid Splashing in Emergency Conditions: where protection is required for response personnel against exposure to chemicals in the liquid state only, when personnel are inside of the danger zone.

(3) NFPA 1993 - Protection Against Hazardous Chemicals in a Non Emergency situation: where protection is required for secondary personnel, where no direct chemical exposure may occur. Activities would include decontamination procedures, or clean up outside of the danger zone.

The development for the need of such requirements is a result of the difficulty and confusion of interpreting manufacturer's data. Different manufacturers often use different tests, testing conditions, and chemicals. Particularly in permeation testing, variables such as temperature, sample size and thickness, permeation cell size, type of analytical instrument and its

sensitivity, gas sampling technique, and sample collection flow rate, affect the results. Many times, only degradation resistance data are presented. Permeation may occur without signs of degradation. Since some results are only based on the manufacturer's experience with the material, it is necessary for garment users to conduct their own testing towards the garment's end use.

Information on sources of supply was collected from various manufacturers. Of those, the following provided chemical resistance data:

Manufacturer	Suit/Suit Material
Chemical Fabrics Corporation	Challenge™/Teflon™ coated Nomex™
Chemron, Inc	Chemtuff™/Proprietary (disposable) Chemrel™/ " " Chemrel Max™/ " "
DuPont	Tyvek QC™/1.25 mil polyethylene (disposable) Tyvek™/Saranex™/single ply (disposable) Tyvek™/Saranex™/two ply (disposable) Barricade™ (disposable)
ILC, Dover	Chloropel™/Chlorinated Polyethylene F.R. Urethane/Polyurethane
MSA	Chempruf™/butyl/nylon Tyvek™ (disposable) UPC/Polyvinylchloride (PVC) Vautex™/Viton™/nylon/neoprene Betex™/Butyl/polyester/neoprene

FYRPEL	PVC Viton™ Butyl Barricade™ (disposable) Tyvek™/Saranex™(disposable)
Rainfair	Polyon™/Polyurethane Nylo-Gard™/Neoprene Acid Suit™/PVC Super Neotex™/Neoprene Nylosear™/Neoprene Vultex™/Styrene-Butadiene Rubber (SBR) Chem-King™/PVC SBR Yankee™/SBR
Edmont	Wet-Wear™/Vinyl
Wheeler Protective Apparel	Acid-King™/PVC or Butyl

CONCLUSIONS

Based on manufacturer's data, the following materials have been selected as candidates towards development of a multi-purpose hazardous chemical protective suit:

(1) Teflon™

(2) Saranex™/Tyvek™

(3) Butyl

(4) Neoprene™

(5) Viton™

(6) Butyl/Neoprene™

(7) Viton™/Neoprene™

(8) Chemtuff™

(9) Chemrel™

(10) Chemrel Max™

RECOMMENDATIONS

Chemical permeation testing, according to ASTM-739-85, "Standard Test Method for Resistance of Protective Clothing Materials by Liquids or Gases", and physical testing must be conducted on these materials. Because of the extensiveness of the shipboard hazardous chemical list, the materials should be tested against the ASTM battery of chemicals, with the addition of fuels, hydraulics and lubricants. The ASTM battery of chemicals includes very corrosive and toxic chemical representatives from the major chemical classes. Testing in accordance with the NFPA methods for chemical protective suit requirements is also recommended, as it would help to standardize manufacturers' data reporting.

FUTURE EFFORTS

The Teflon suit material, by Chemical Fabrics Corporation, is one of the most extensively tested materials. It has the best chemical resistance, but is extremely expensive. This material is typically used for a Level A situation. This material will not be tested for chemical resistance. The Saranex coated Tyvex material will be laboratory evaluated because it is currently being implemented as the protective suit material for the hazardous spill kit developed by NAVSES. Efforts will be coordinated between NCTRF and NAVSES. This material is used often in situations requiring Level B or C protection.

Based on laboratory generated data, a candidate suit material will be selected. The suit material will be accepted under either the manufacturer's current design or it will be designed under specifications developed by NCTRF.